



original article



## Clinical outcomes of arthroscopic lateral ligament repair using a knotless anchor for chronic lateral ankle instability

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### ABSTRACT

**Background/objective:** Arthroscopic lateral ligament repair (ALLR) for chronic lateral ankle instability (CLAI) has been improving with technical innovations. However, there is a lack of information regarding mid- and/or long-term clinical outcomes after the introduction of ALLR. This study aimed to report mid-term clinical outcomes of ALLR with a knotless anchor.

**Methods:** Thirty-two patients (11 men and 21 women; mean age, 28 ± 14 years) who underwent ALLR with a knotless anchor from December 2015 to October 2020 were included. The mean follow-up period was 31 ± 11 months. The Japanese Society for Surgery of the Foot (JSSF) ankle-hindfoot scale and the Self-Administered Foot Evaluation Questionnaire (SAFE-Q) were used for clinical evaluation preoperatively and at the 2-year follow-up. Surgical complications, particularly knot irritation, were also examined.

**Results:** The JSSF scale scores were significantly improved, from 71.3 ± 13.1 preoperatively to 96.6 ± 5.1 postoperatively (P < 0.05), and the SAFE-Q showed similar improvement in all subscales (P < 0.05). One case had a complication of persistent pain around the lateral portal (3.1%).

**Conclusion:** ALLR using a knotless anchor provided satisfactory clinical outcomes over 2 years, and no major complications, such as knot irritation, were observed.

**Case series:** Level of Evidence, 4.

## 1. Introduction

Most patients with a lateral ankle sprain can obtain satisfactory results with 3–6 months of conservative treatment. However, 10–30% of these patients develop chronic lateral ankle instability (CLAI).<sup>1,2</sup> CLAI not only reduces participation in sporting activities and activities of daily living but also has the potential to develop into posttraumatic ankle osteoarthritis.<sup>3,4</sup> The Broström and Broström–Gould procedures have long been considered the gold standard for treating CLAI, showing good to excellent results.<sup>5–7</sup> Arthroscopic lateral ligament repair (ALLR) has been introduced as an alternative, with clinical results similar or superior to those of open surgery.<sup>8–11</sup>

However, knot irritation has been reported to be a major complication of ALLR.<sup>10,12</sup> Recently, knotless anchors for ALLR have been introduced to avoid knot irritation.<sup>13,14</sup> Vega et al.<sup>15</sup> reported good results for ALLR with a knotless anchor. Kanzaki et al.<sup>16</sup> also reported good

short-term results for a new ALLR procedure using a knotless anchor. ALLRs using a knotless anchor could provide satisfactory clinical outcomes; however, up to mid-term follow-up results have been reported, as these techniques were very recently introduced. Therefore, this study aimed to evaluate the mid-term results of ALLR using a knotless anchor.

## 2. Materials and methods

Patients who had CLAI and underwent a designated ALLR with a knotless anchor, as described by Kanzaki et al.,<sup>16</sup> from December 2015 to October 2020 were included in this retrospective study. This study employed a consecutive case series design, where all eligible cases were included sequentially and subjected to the same treatment protocol. CLAI was diagnosed based on patients' medical history, physical examinations, and ultrasonographic findings. Medical history included history of a sprain and current symptoms. Physical examinations

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included an anterior drawer test to evaluate anterior ankle instability. Ultrasonography was used to compare the affected side with the contralateral side. Although magnetic resonance imaging (MRI) is also commonly performed, we did not use MRI in this study to determine whether repair or reconstruction was needed. We performed arthroscopic repair in all cases diagnosed as CLAI. Conservative therapy was initially prescribed to treat CLAI, and ALLR was indicated when conservative therapy was ineffective for more than 3 months. The exclusion criteria were the use of other types of surgical implants and concurrent pathologies requiring additional surgical procedures, such as osteochondral lesion of the talus (OLT), os tibiale externa, peroneal tendon dislocation, or revision surgery. We specifically focused on the outcomes of ALLR for CLAI treatment. Cases including simple resection of osteophytes, os trigonum, or os subfibulare were included.

A total of 113 surgeries were performed during this study. Fifty participants (44%) who dropped out due to distant locations or voluntary suspension were excluded. Only patients who could visit the hospital were included in the study because SAFE-Q is a self-administered patient-oriented assessment instrument. Due to technical difficulties with the SAFE-Q, no telephone or e-mail surveys were conducted. Many of the patients were young, in their teens and twenties, and had moved away from our hospital coverage area; these patients were unable to return for the long-term follow-up assessment and were consequently excluded from the study. Eleven patients were excluded because they received a different type of anchor. Four patients with obesity had an internal brace inserted at the ankle joint. At our institution, we believe that patients with obesity cannot maintain ankle joint stability with ALLR alone, so we add internal braces at the ankle joint. The four patients were excluded to avoid the influence of the internal brace. Nineteen patients were excluded because of OLT or other comorbidities. Ultimately, 32 patients were included (11 men and 21 women), with a mean age of  $28 \pm 14$  (range, 13–59) years and a mean follow-up period of  $31 \pm 11$  (range, 24–59) months. The study was approved by the review board of our institution, and informed consent was obtained from all patients.

### 2.1. Operative technique

ALLR was performed according to the methods described by Kanzaki et al.<sup>16</sup>

First, ankle joint arthroscopy was performed with standard anteromedial and anterolateral portals. An accessory anterolateral portal was then created 1.5 cm proximal to the tip of the lateral malleolus and 1.0 cm anterior to the margin of the fibula. The anterior talofibular ligament (ATFL) attachment site of the fibula was identified and decorticated using an abradar. A knotless suture anchor (SutureTak<sup>®</sup>; Arthrex Inc., Naples, USA) was embedded in the ATFL attachment site (Fig. 1). The anchor has a suture string and a passing wire that leads the suture string into a self-locking system. The sutures were passed through the joint capsule, conjoint fibre of the ATFL, and calcaneofibular ligament (CFL) using a Micro SutureLasso<sup>®</sup> (Arthrex Inc., Naples, USA) (Figs. 2 and 3). The suture lasso was placed using the tip of the lateral malleolus as a landmark. The suture string was relayed to the passing wire and tightened. Ultimately, the suture string was secured to the self-locking system inside the anchor.

Postoperatively, cast fixation was performed in the operating room. Cast immobilisation was applied for 3 weeks, while allowing weight-bearing as tolerated. Formal functional training was initiated after cast removal, with particular emphasis on strengthening the peroneal muscle. The ankle brace was worn continuously for the first 12 weeks after surgery and then worn only for contact sports for the following 6 months. Patients were allowed to return to sports approximately 3 months after the operation.

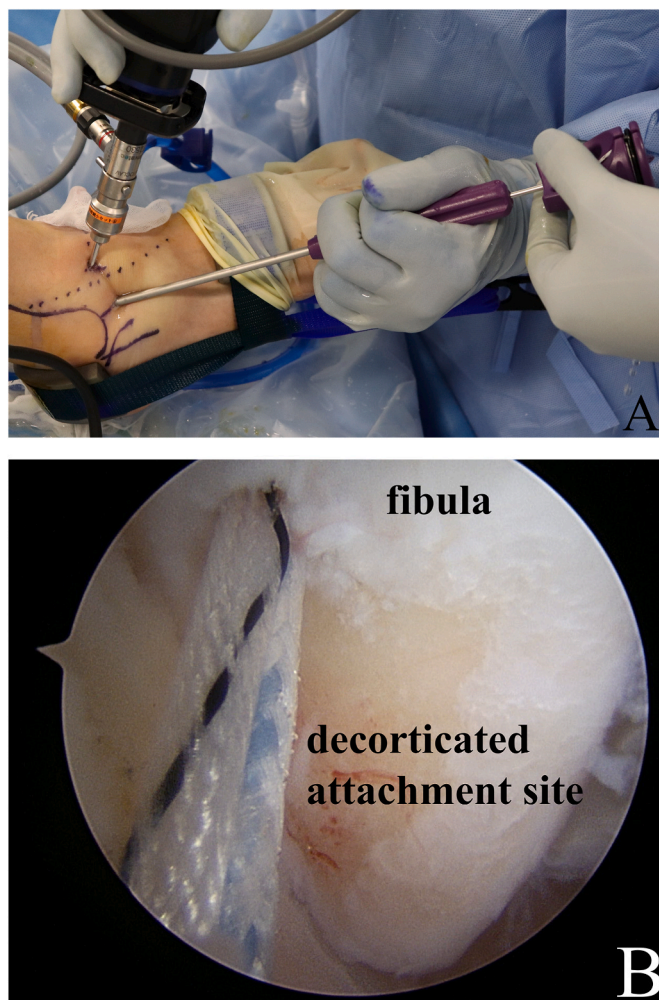


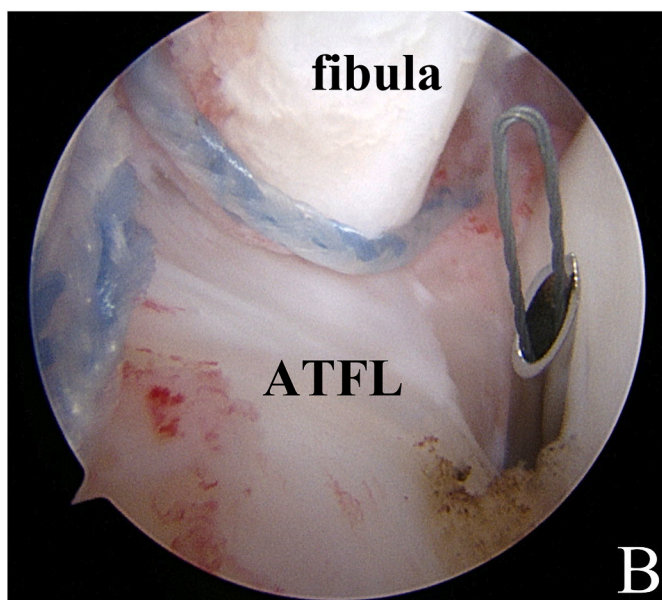
Fig. 1. Embedding of the knotless suture anchor (A) A knotless suture anchor was embedded in the ATFL attachment site. (B) Arthroscopic view.

### 2.2. Clinical outcome

Clinical scores of the Japanese Society for Surgery of the Foot Ankle-Hindfoot scale (JSSF scale) and the SAFE-Q were obtained preoperatively and at the final follow-up. The JSSF scale is an objective evaluation tool designed by the Japanese Society for Surgery of the Foot (JSSF), which has a maximum score of 100 points, comprising 40 points for pain, 50 points for function, and 10 points for alignment.<sup>17,18</sup> The SAFE-Q is a patient-reported outcome method devised by the JSSF; it consists of the following subscales: pain and pain-related, physical functioning, social functioning, shoe-related, general health and well-being, and sports activity.<sup>19</sup> Both scoring systems have been validated. Complications after ALLR were also examined with a focus on knot irritation.

### 2.3. Statistical analysis

Shapiro-Wilk test was conducted to test for normality; the data was not normally distributed. Consequently, the Wilcoxon signed-rank test was used to analyse the differences between preoperative and final follow-up scores. Statistical analysis was performed using EZR 1.54 (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R 4.0.3 (The R Foundation for Statistical Computing, Vienna, Austria).<sup>20</sup> Statistical significance was set at  $P = 0.05$ . This study was designed with the JSSF scale as the main outcome measure, and the sample size was determined accordingly. For the



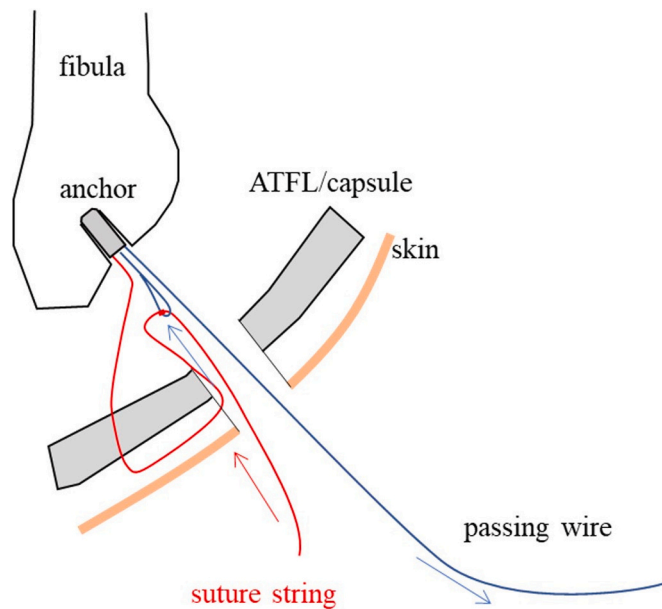
**Fig. 2.** Induction of passing suture using Micro SutureLasso<sup>®</sup> (A) The suture is passed through the joint capsule and conjoint fibre of the ATFL and CFL using a Micro SutureLasso<sup>®</sup>. (B) Arthroscopic view.

analysis of a comparison between two paired groups, considering a mean difference of 23, a standard deviation of 11.6, an alpha error of 0.05, and a power of 0.8, the required sample size was calculated as 5. Thus, the sample size used in this study was considered statistically appropriate.

### 3. Results

JSSF scale scores improved significantly, from a mean preoperative score of  $71.3 \pm 13.1$  (range, 40–92) to a mean follow-up score of  $96.6 \pm 5.1$  (range, 85–100), ( $P < 0.05$ ). Mean SAFE-Q scores also improved for all subscales (pain and pain-related, from 63.1 to 91.9; physical function and daily living, from 72.3 to 93.8; social function, from 71.6 to 96.4; shoe-related, from 69.3 to 93.5; general health and well-being, from 64.7 to 95.8; and sport, from 51.1 to 92.0;  $P < 0.05$  for all; [Table 1](#)).

One patient had a surgical complication (3.1%), which was residual pain in the anterolateral portal. Synovitis was observed in the painful area on ultrasonography. The pain resolved 1 year after surgery with conservative treatment. One patient experienced an acute traumatic ankle sprain in a gym class 1 year after the operation, which was conservatively treated successfully without recurrent instability symptoms.



**Fig. 3.** Schema of the knotless anchor technique. The anchor has a suture string and passing wire, which leads the suture string into a self-locking system. The sutures were passed through the joint capsule, conjoint fibre of the ATFL, and calcaneofibular ligament using a Micro SutureLasso<sup>®</sup> (Arthrex Inc., Naples, USA). The suture string was relayed to the passing wire and tightened by pulling it. Adapted from ‘A Novel Technique of Arthroscopic Ankle Lateral Ligament Repair Using a Knotless Suture Anchor’, by Kanzaki et al., 2020, The Orthopedic Journal of Sports Medicine, 8(11), p. 5, Fig. S8. Copyright 2020 by the Name of Copyright Holder.

**Table 1**

Comparison of clinical outcomes preoperatively and at final follow-up. a The Wilcoxon signed-rank test was used to analyse differences in all variables and significance was set at  $P < 0.05$ . b The values are given as mean  $\pm$  standard deviation. SD, standard deviation.

Evaluation Tools (mean $\pm$ SD)	Preoperative	Final follow-up	P value <sup>a</sup>
JSSF scale <sup>b</sup> (points)	$71.3 \pm 13.1$	$96.6 \pm 5.1$	$<0.001$
SAFE-Q <sup>b</sup> (points)			
Pain and pain-related	$63.1 \pm 25.9$	$91.9 \pm 10.3$	$<0.001$
Physical function and daily living	$72.3 \pm 25.5$	$93.8 \pm 7.9$	$<0.001$
Social functioning	$71.6 \pm 25.5$	$96.4 \pm 7.5$	$<0.001$
Shoe related	$69.3 \pm 28.4$	$93.5 \pm 11.7$	$<0.001$
General health and well-being	$64.7 \pm 24.7$	$95.8 \pm 8.2$	$<0.001$
Sports activity	$51.1 \pm 24.2$	$92.0 \pm 12.7$	$<0.01$

### 4. Discussion

The most important finding of the present study was that ALLR with knotless suture anchors demonstrated satisfactory clinical results at the 2-year follow-up, without major complications.

Knot irritation is a worrisome complication of ALLR.<sup>23,24</sup> According to a report by Qin et al.,<sup>25</sup> one patient (3%) out of 39 developed keloids around the knot site after arthroscopic ATFL repair.<sup>25</sup> Yeo et al.<sup>10</sup> reported that two (8%) out of 25 ALLR patients had knot pain requiring knot removal.<sup>10</sup> Knotless anchors are becoming increasingly popular in ALLR as a means of avoiding knot irritation; however, mid- and long-term evidence supporting the effectiveness of knotless anchors in the literature is limited.

Giza et al. reported that there were no statistical differences in the strength or stiffness between a traditional open repair and an arthroscopic anatomic repair.<sup>26</sup> Biomechanical studies have been conducted to compare suture anchors with and without knots, and comparable or favourable biomechanical strength has been achieved using knotless

anchors.<sup>27,28</sup> Thal et al.<sup>29</sup> reported that the knotless anchor was significantly stronger than other anchor types in the failure of suture strength test; however, there was no difference in the pull-out strength test. Li et al. reported that ligament tension, ultimate failure load, and pull-out stiffness were similar between the knot repair and knotless repair techniques.<sup>30</sup> Knotless anchors are considered acceptable alternatives in terms of their biomechanical properties.

There are few reports on the mid- and long-term functional outcomes of conventional ALLR. Arthroscopic Broström–Gould repair has been found to provide good-to-excellent clinical results (94.7%) at a mean follow-up of 9.8 years.<sup>21</sup> Feng et al.<sup>22</sup> reported favourable clinical results at a 2-year follow-up after arthroscopic ATFL repair. Thus, the current study demonstrated a new technique with clinical results comparable with those of previous reports. There are similar reports of mid-term clinical results using knotless anchors.<sup>9,11</sup> Li et al.<sup>31</sup> utilised a technique similar to that used in the current study, in which the isolated ATFL was repaired using a single knotless anchor. They reported no significant differences in clinical outcomes between the knot and knotless anchor groups at a 2-year follow-up.<sup>31</sup> As there was a lack of preoperative information, it was unclear to what extent their technique improved clinical outcomes. In addition, patients with osteochondral defects were not excluded. In contrast, the present study focused on CLAI in isolation, excluding cases with concurrent pathologies that could affect clinical outcomes. Chen et al.<sup>32</sup> reported on 68 cases with an average follow-up period of 42 months, in which ALLR was performed. They observed significant improvements in the American Orthopedic Foot and Ankle Society (AOFAS) score, Karlsson Ankle Functional Score (KAFS), Foot and Ankle Outcome Score (FAOS), Tegner score, and Numerical Rating Scale (NRS) score from preoperative to postoperative assessments. Although their surgical technique differs slightly from ours, a common feature is the use of knotless anchors. Similar to our study, they reported favourable outcomes. Chen et al. reported in their study that older age, female sex, and concomitant injuries were risk factors for poor postoperative outcomes through multiple linear regression analyses. In the additional investigation conducted in our study, older age was considered a factor influencing postoperative outcomes, but sex was not significantly associated with postoperative outcomes. Lee et al.<sup>13</sup> noted that a knotless anchor obviates the need for knot-tying, which simplifies the procedure, and that the tension of the suture can be adjusted by pulling it. Another case series of 16 patients demonstrated an improvement in patient-reported clinical outcomes after a mean follow-up of 22.3 months, although some complications occurred, including superficial infection and delayed wound-healing (one patient each).<sup>15</sup> The present study has a comparable sample size and follow-up duration to those of previous clinical reports of ALLR with knotless anchors. Similar to previous findings, no knot irritation was observed. Knotless anchors are useful for ALLR, as they prevent knot irritation and simplify the surgical procedure.

This study had several limitations. First, the sample size was small. Although this study was a case series without statistical comparison between the groups, a larger number of patients would demonstrate the additional benefits and/or complications associated with our technique. A total of 50 cases were excluded, as many of the patients were young, and long-term follow up was not possible due to the moving away of patients. Second, the post-treatment in this study was a conservative protocol involving 3 weeks of cast immobilisation, which is an old-fashioned immobilisation duration. In the future, the duration of fixation will be shortened. Third, we did not use the AOFAS or Karlsson–Peterson ankle scores, both of which are globally used clinical scores. Instead, we used the JSSF scale and SAFE-Q, which were developed and validated in Japan. In the future, we will use the AOFAS and Karlsson–Peterson ankle scores and make efforts to popularise the JSSF scale and SAFE-Q, which are currently gaining recognition. Fourth, this was a case series; further comparative prospective studies are required to demonstrate the benefits of the knotless technique over other conventional procedures.

In conclusion, ALLR with knotless anchors provided satisfactory clinical outcomes at the 2-year follow-up without knot irritation. Knotless anchors are useful for ALLR, as they prevent knot irritation and simplify surgical procedures. Further studies with larger sample sizes and a comparative group are needed.

### Authorship

All authors made substantial contributions to either the original research, acquisition, analysis, or interpretation of data, drafting of the paper, critical revisions, or approval of the submitted and final versions.

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### Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT in order to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

### Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online. The authors received no financial support for the research, authorship, and/or publication of this article.

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